~~SECRET~~

OG-400

COPY No. 1

HESSE-EASTERN

A DIVISION OF

FLIGHTEX FABRICS INC.

[redacted]

EVERETT, MASS.

PRODUCT
PROCESS
Engineering

REPORT NO. 8-60-50G-111

MONTHLY PROGRESS REPORT

ENGINEERING PROGRAM FOR

THE PILOT PRODUCTION OF A

LIGHTWEIGHT ANTITANK WEAPON

FOR THE PERIOD

MONTH OF AUGUST 1960

CONTRACT NO. RD-142

ORDNANCE PROJECT NO.

DEPT. OF ARMY PROJECT NO.

This document contains information affecting the national defense of the United States within the meaning of the Espionage Laws, Title 18, U. S. C., Sections 793 and 794. The transmission or the revelation of its contents in any manner to an unauthorized person is prohibited by law.

~~SECRET~~

Declassified and Approved For Release 2011/11/08 : CIA-RDP78-03642A000800060006-1

HESSE - EASTERN DIVISION

FLIGHTEX FABRICS, INC.

PROGRESS REPORT #4

ENGINEERING PROGRAM FOR THE PILOT PRODUCTION OF A LIGHTWEIGHT ANTITANK ROCKET

AUGUST 1960

CONTRACT NO. RD-142

PREPARED BY: Thomas H. Forman
Thomas H. Forman
Project Engineer

APPROVED BY: Charles B. Weeks
Charles B. Weeks
General Manager and
Technical Director

SUBMITTED BY: HESSE-EASTERN DIVISION
FLIGHTEX FABRICS, INC.
EVERETT, MASSACHUSETTS

WORK ACCOMPLISHED DURING THE MONTH OF AUGUST 1960

SYSTEM EVALUATION PROGRAM

The fuze problem has been solved and fuze functioning was re-established by conducting a firing test of 10 hot and 10 cold rounds with 100% functioning. The necessary changes on the drawings were made and replacement components ordered for the ones which have appeared to be the cause of the trouble.

Difficulties were experienced in the assembly of the launchers, and it was found that some of the tooling used to assemble launchers had to be changed. This was done, and all launchers assembled in the original way were checked and all faulty ones taken apart and properly re-assembled. A firing test of a total of 13 rounds was conducted at the cold temperature to check out the functioning of the system, in addition to extensive tests of launchers with dummy rounds which were conducted in the Lab. All this testing was done at the cold temperature, since the faulty assembly only produced difficulties in firing a system at the cold temperature.

In the course of this testing it was found that a very dangerous problem has been introduced by the substitution of the aluminum barrier between the motor and the head for a steel barrier, as used during the R&D program. This change was made in order to reduce the missile hazard created by the steel barrier when the round exploded on a near target. During one of the launcher tests the threads of the motor barrier and the practice head stripped off, allowing the burning of the propellant to take place inside the plastic launcher tube. This caused the tube to shatter and inflicted injuries to the person who fired the weapon. The weapon was shoulder fired to check out the actual feel of trigger pull at the cold temperature and to expedite testing, since trouble with the firing fixture would otherwise have caused a delay. This problem received immediate top priority. Investigation showed that in the case of undersized aluminum barriers, paired with practice heads, such an occurrence is possible. Tests showed that when using aluminum barriers, all barriers of rounds fired at the cold temperature were hard or impossible to unscrew. This had never been the case with steel barriers and indicated that a marginal condition exists when using aluminum barriers. Checking of components has shown that some of the aluminum barriers were undersize, which, of course, increases the problem. A decision was made to discard all the aluminum barriers and to use steel barriers instead. Shear strength and tolerances are being studied in order to eliminate any future trouble.

The remainder of the program is moving along at the expected rate, and it is fully expected that once the present problems have been eliminated the rate of producing and testing weapons will conform to the original estimate. However, some time will have been consumed and some funds used for purposes not originally foreseen. The extent of the additional time and funds which will be required will be determined as soon as all check-out tests are finished and all additional components ordered.

The canning machine has been suitably modified, and, after canning a number of dummy systems at Everett, the machine was moved to the J-2 Range where it is presently being installed.

HEAT HEAD EVALUATION PROGRAM

All heads have now been received from Eastern Tool & Mfg. Company. The quality of the metal components is as good as previously. However, some thirty heads had to be rejected for various dimensional discrepancies.

Loading of the heads has been started, but it was found that the aluminum funnels as used in the R&D program were not suitable for the somewhat larger scale of production which is now in process. A new funnel was therefore designed (Dwg. No. B-8692, Appendix). This incorporates an O ring seal, which prevents the molten Composition B from rising between the funnel and the inside of the fuze cavity in the head. This has been happening with some of the heads which were loaded with the old funnels, making it hard, and in some cases impossible, to remove the funnel. Fifty such funnels are presently being machined, and it is expected that the first batch of heads will be satisfactorily loaded in September. Loading so far has been conducted on a small scale basis until a good pour could be obtained consistently and at a good rate of production.

As decided at a meeting with the Project Officer, each head will be x-rayed, and arrangements have been made to have this done promptly when heads come off the production line.

It is also planned to run a comparative static penetration test of five new heads against five heads left over from the R&D program. This test will be run against mild steel plate, which is permissible in this case since the evaluation can be made on a purely relative basis.

The problems encountered in the fuze and motor area, together with the accident which put the project engineer out of action for more than a week, all these complications have made it impossible to run train functioning tests (RDX versus Tetryl boosters) with the improved fixtures which are ready for use. Tests will probably be conducted in September.

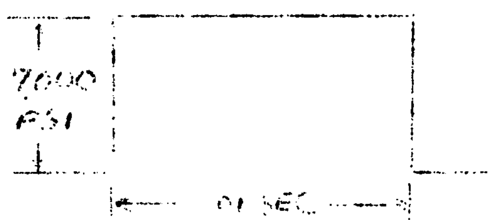
MOTOR EVALUATION PROGRAM

As mentioned in the introduction to this report, a failure of a barrier and a practice head occurred during cold temperature tests. In order to obtain more information on the subject of the barrier failure and in order to complete the tests of launchers during which the accident had occurred, ten more rounds were fired under conditions identical to the three which were shoulder fired, only this time the improved launching fixture was used. All rounds functioned properly. However, as was discovered in the case of the cold fuze rounds, the barrier threads were impossible to unscrew after firing. This problem is being very thoroughly analyzed. It appears, however, that the following factors all contribute to the problem. They are discussed below in the order of their importance:

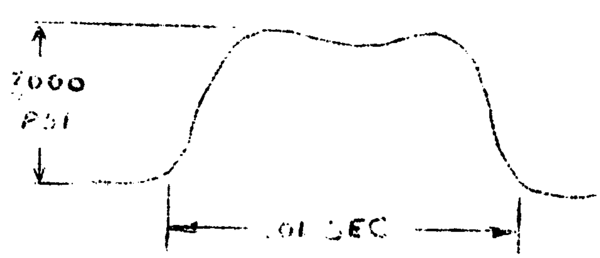
<u>1) The interior ballistics of the rocket</u>.

The force acting on the motor barrier is created by the pressure inside the motor. This pressure is generated by the burning propellant. The rate at which pressure builds up and the rate at which it is reduced back to atmospheric pressure have an effect on the vessel containing this pressure. This effect has to be considered in addition to the value of the pressure.

The motor design calls for an operating pressure of approximately 6000 psi for a time duration of .010 seconds. As we know, the actual performance of the motor does not quite correspond to these design criteria. If the above statement were completely fulfilled in the present motor, the time vs. pressure curve obtained from this motor would be a square wave as follows:



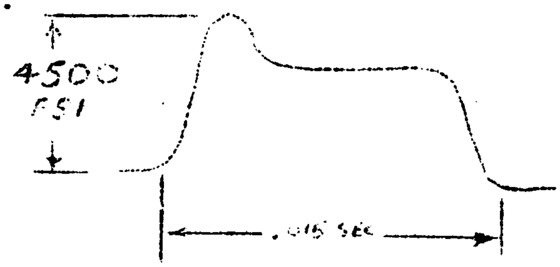
As previously discussed, this ideal situation is not adhered to in this case. In fact, it is almost impossible to have any rocket motor produce a perfect square wave. A typical time-pressure curve of a standard rocket motor might well look like this:



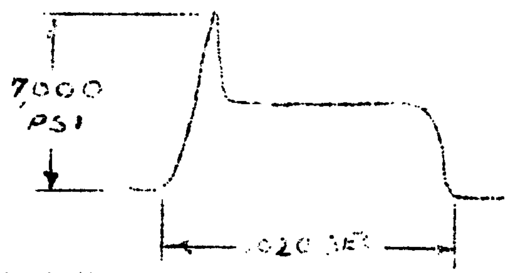
As can be seen, the rise and drop are not vertical and the pressure plateau is not perfectly horizontal.

SECRET

Due to considerations of security, which made it necessary to "sterilize" the design of this particular motor, the typical time-pressure curve obtained from it may vary from a curve obtained at the hot temperature with this shape:



to a curve obtained at the cold temperature having this shape:



The peak formed at the beginning of the burning time is more pronounced at the cold temperature.

This sudden loading and unloading creates a stress condition on the vessel containing the pressure which is very difficult to evaluate fully. The sudden unloading after a very short duration of the peak pressure may set up stresses caused by oscillation far in excess of anything created by the nominal value of the peak pressure. In addition to this consideration it is possible that since the peak rises so suddenly the curve in some one rocket may keep on going up higher than average, thus creating an excessive peak pressure.

SECRET

It would, of course, be impossible to change this situation without redesigning the interior ballistics. This would result in the fact that the present motor components and propellant assemblies could not be used. Security reasons quite apart from cost reasons make this course of action highly undesirable. In addition, we have a statistical background of more than 1000 rounds with steel barriers which were fired without any failure of this type during the R&D program. If the round which separated had been the only one which showed any indication of trouble, this statistical sample would not be too meaningful in the light of the considerations of interior ballistics as above. However, it was observed that all aluminum barriers fired under cold temperature conditions showed some deformation in the threads; i.e., all threads of cold rounds with aluminum barriers fired were difficult to impossible to unscrew after firing.

It may therefore be possible to assure safety for this lot of motors by changing to steel barriers. However, it is felt that if the sterility requirements could be changed in such a manner as to permit the use of propellant more nearly of a standard size, an improved motor could be designed which would not imply the hazard of the peak in the time-pressure curve. Such a motor would, in addition, have the great advantage of making use of more readily producible propellant, which would decrease the cost of each round very substantially. This is meant as a suggestion for future improvement and cost reduction.

2) The strength of the threaded closure.

The following computations show the stress set up in the motor and compare this to the strength of the threaded closure using both steel and aluminum.

Calculations Re Strength of Motor and Barrier Threads

1. Shear Areas

At minor diameter of female thread of motor. This is the area which applies if the strength of components is such as to have the barrier fail before the threads in the motor can fail.

Min. Shear Area

Max. Dia. 1,721 Circumference 5.4066

Width of tooth in shear .0326 (from 100 to 1 layout)

5.4066 X .0326 X 4 = $.705 \text{ in}^2$

At O.D. of major diameter of barrier. This is the area which might fail if the strength of the barrier material is a great deal less than the strength of the motor.

Major Dia. of Barrier 1.765 (min.)

Width of motor tooth at this point .0486

5.54 X .0485 X 4 = 1.076 in^2

2. Force Applied

The pressure in the motor is applied to the whole area of the motor barrier. We find that the area of the barrier is 2.16 in^2. If we assume a max. pressure of 7000 psi, we arrive at:

2.164 X 7000 = 15,148 lbs. pressure exerted on the barrier.

3. Stress Exerted

By motor pressure of 7000 psi on the following:

A) The barrier at minor dia. of motor thread -

$$S = \frac{P}{A}$$

$$P = 15,148 \text{ lbs.}$$

$$A = .705 \text{ in}^2$$

$$\frac{15,148}{.705} = \underline{\underline{21,500 \text{ lbs. per in}^2}}$$ Stress At Minor Dia. of Motor Thread

B) On the motor thread at the O.D. of the barrier -

The area in this case is 1.076 in^2

$$\frac{15,148}{1.077} = \underline{\underline{14,000 \text{ lbs. per in}^2}}$$ Stress At Major Dia. of Barrier

It follows that the yield strength of whatever material is used in the barrier must exceed the value of 21,500 psi. The value for the motor material must exceed 14,000 psi.

4. Strength of Materials

C 1117 Steel (used in barrier during R&D Program) - Yield point in shear	74,000 psi
2024 Aluminum (used in new barriers) Yield point in shear	28,000 psi
7001 Hunter Douglas ZG 73-T6 Aluminum Alloy - Yield in shear	64,000 psi

5. Safety Factors

Steel Barrier	2.75
Aluminum (2024) Barrier	1.3
Motor Thread	4.57

This shows that the 2024 Aluminum barrier may very well be marginal, especially if any particularly strong peak (on cold temperature) in the pressure or an unusually weak section of thread on the practice head are added to the consideration. The strength of the threads in the heads have not been taken into consideration in any of the above. However, it must be pointed out, particularly in the case of the HEAT head, which has a steel thread, that the above factors would almost double if the additional strength of the thread in the head is added. It is felt that the change to a steel (C 1117) barrier is more than justified as a result of the above.

3) The design of the thread itself.

The computations under 2) above assume the thread form which was originally adopted. This is a standard V-type thread. When a load is being placed on the motor barrier, this thread shape will create a force which tends to expand the threaded portion of the motor due to the angular contour of the thread. If a buttress type thread would be substituted, this outward moment would be eliminated.

The same applies to this point as was stated regarding point 1), namely, that a change in this respect would mean a very considerable delay in finishing the pilot production lot because of the necessity of discarding all existing motors and the additional necessity of running a test program to confirm the theoretical design. The figures also show that the steel barrier could provide enough safety for the present purpose.

SECRET

FUTURE PROGRAM RE BARRIER

A thorough study of the thread properties of the present motor and the steel barrier will be compiled in September. The tolerances will be more accurately defined than is presently the case. In addition, the decision was made not to shoulder fire any of the test round of the pilot production lot in order to get a sample lot of successful firings large enough to justify shoulder firing again.

FUZE EVALUATION PROGRAM

As discussed in the July report, a test of 15 rounds, using the longer spring, was prepared and conducted on 29 July. It was felt at the time (and justifiably so) that this test would better be reported in the August report in order to give a more rounded picture of the work done in connection with the fuze problem.

This test showed that at a temperature of 140°F all fuzes functioned properly. (See Test Tabulation in Appendix.) Accordingly, it would have been justifiable to make the necessary changes and incorporate the longer spring, which is nothing more than more clearly defining the spring which was used during the R&D program. However, in the meantime static test work had been conducted which showed that, when inserting a small lead ring behind the triggering sleeve (as discussed last month) the incidence of bounces on static drop tests was reduced to one out of thirty, which is a signal improvement over any combination previously tested. Tests to check out the reliability of this design were conducted on

SECRET

5 and 17 August. (See tabulation, Rounds 980-999.) All fuzes functioned properly. Due to the fact that some of the cold rounds did not show proper ignition and did not achieve the full round velocity, functioning under exceptionally low acceleration was shown by these tests. The improper ignition was caused by re-used motors having excessively eroded throats. The temperature of the hot rounds was purposely elevated to +140°F in order to prove that a margin of safety exists from the point of view of exceptionally hot conditions.

A study of the room available for the additional lead ring and of the maximum and minimum size of this ring has shown that, by machining the triggering sleeve slightly deeper in one direction (Dwg. No. A-8153, Rev. 4, Appendix), safe and consistent functioning may be established. The drawings have been accordingly changed and the re-machining of the triggering sleeves ordered.

As mentioned in the July report, the firing spring had to be changed in order to re-establish functioning and to eliminate bouncing. The new springs have been obtained and the drawings changed.

The fuze difficulties have necessitated the use of a certain number of components which will have to be reordered so as not to run short of the stipulated quantity for the pilot production lot. An excessive amount of engineering time also had to be spent on this task. At a meeting with the Project Officer, the decision was made to have Hesse-Eastern submit a proposal for the time and materials which this unforeseen R&D work has required. This will be done as soon as it is felt that all the problems have been attended to successfully and as soon as any and all tests needed to prove out the changes have been conducted and all funds for required components have been committed.

The specifications will have to be written more tightly as far as quality control of individual components is concerned, since this has been the principal cause for the trouble with the fuze.

LAUNCHER EVALUATION PROGRAM

When conducting the fuze test at the cold temperature on 5 August, it was found that erecting the trigger handle caused so much friction in the swivel sleeve assembly (the assembly in the rear of the launcher which operates the actuating lever in the igniter assembly), the actuating lever was prevented from properly operating and pushed over to one side to such an extent that it jammed in the rear band around the launcher. Investigation showed that the location of the swivel sleeve in the case of most of the launchers assembled to this point was improper. This had been caused by the operator pulling the locating fixture, which is used to locate the swivel sleeve, forward of the launcher when assembling the firing mechanism assembly.

In order to make it impossible to repeat such improper assembly practices, the locating fixture was changed in such a manner that it is securely locked to the launcher and kept in place until assembly is complete. (See photographs in Appendix.)

A procedure for reworking the launchers was then established, and all launchers which have been produced prior to this discovery were examined and reworked if this proved to be necessary. It was possible to repair all launchers which have been wrongly assembled, and assembly then continued with the new fixture.

Currently over 800 launchers have been produced and are being stored at the J-2 Range.

Ten launchers, properly assembled, were stored in dry ice overnight, thus causing very excessive cold conditions. All functioned properly and showed reasonable trigger pull. This test was conducted in the Lab and was followed by a firing test on 25 August, when six systems were prepared for dynamic firing, being conditioned to a temperature of -30°F.

A great deal of trouble was experienced with the launching fixture, and it became apparent that this would require some minor rework of the fixture in the machine shop. The delay which all these difficulties cause the program was very acutely felt at this time, and the decision was therefore made by the writer to shoulder fire the systems. This was done, and the first two rounds were successfully fired, showing very acceptable trigger pull and being quite easy to get into the "ready" position as far as the safety handle was concerned. The third round was equally easy to erect. However, when I fired it (the trigger pull being - I thought - light), the launcher blew up, which was caused by the failure of the motor barrier, as discussed in the Motor Evaluation Program section. Since no rounds had previously been shoulder fired at cold temperature, I had taken the precaution of donning a bulletproof vest and placing another over my head and right shoulder for protection. I sighted through the armhole of the second vest. The injuries obtained were not too serious, consisting of cuts around the right eye and nose and burns in the face. A launcher fragment entered my right arm, injuring a sensory nerve. Based on the injuries received, it must be concluded that a similar accident without the use of protective clothing might very well be fatal. This fact is being mentioned in order to aid in the proper evaluation of the decision not to shoulder fire the test samples of the pilot production lot.

PILOT PRODUCTION

A regular schedule for the production and shipment to the range area of launchers has been set up. As previously mentioned, more than 800 launchers are ready for loading. The fixtures for aiming and evaluating the armor plate penetration tests have been made and are presently being erected at the range. The facilities for storing components as they are received for final loading are being made ready, and it is hoped that final loading will start late in September or early in October. The timing now depends on obtaining fuze components, reworked to the new drawings,and on assembling same into fuzes ready for loading. The speed at which the heads will actually be loaded is not a known factor as yet either. As soon as more exact information as to the extent of the delay in time is available, it will be communicated to the Contracting Officer.

TABULATION OF TESTS

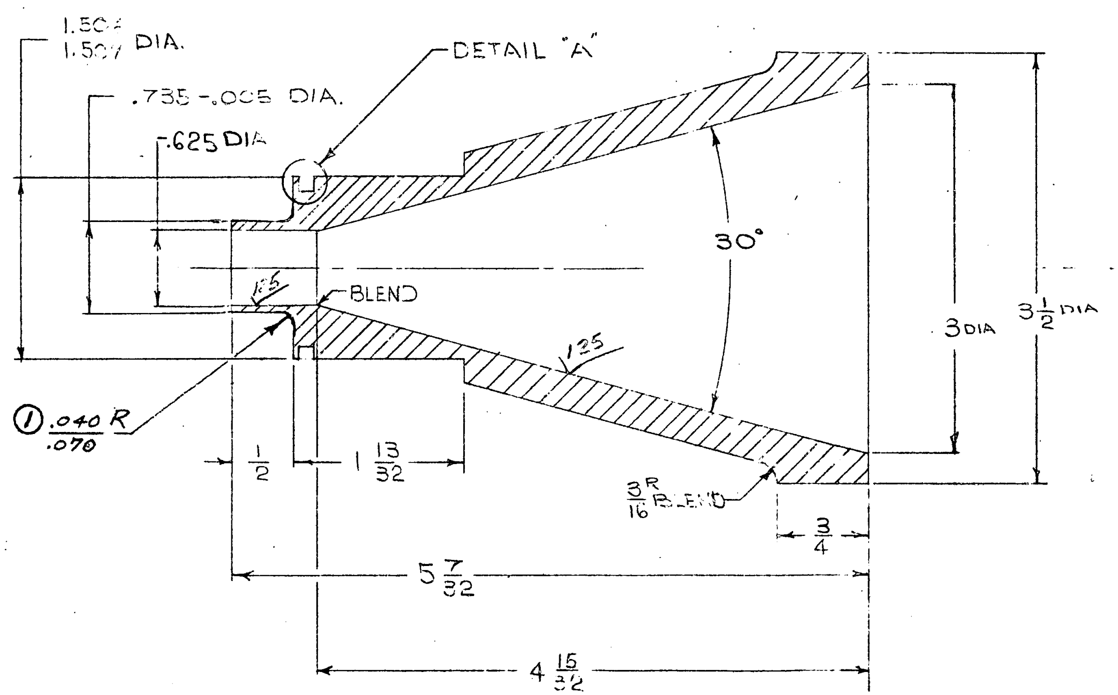
AUGUST 1960

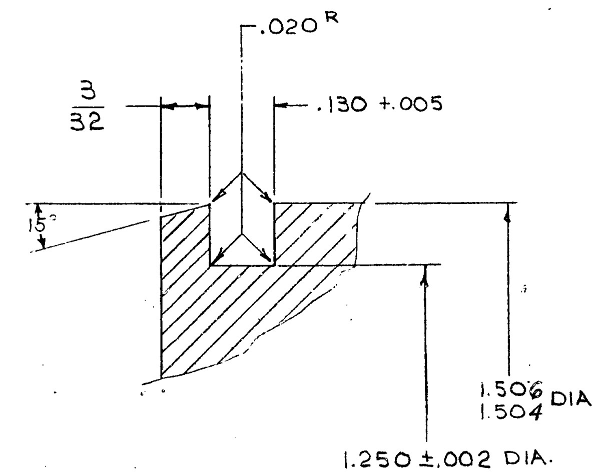
CONDITIONS APPLYING TO ALL ROUNDS FIRED: Complete systems were used. Approximately half of the fuze rounds made use of HEAT heads with dummy boosters. Dummy detonators were used in all fuzes. Time between removal from conditioning box and firing, from 1-3 minutes.

Round #	Date	Temp. °F	Test Purpose	Method of Firing	Result
965-979	7/29	+140	Fuze with proper firing spring.	Stand	Fuze OK.
980-989	8/5	+140	Fuze with proper firing pin spring and lead ring.	Stand	Fuze functions OK.
990	8/5	-25	Fuze with proper firing pin spring and lead ring.	Stand	Fuze functions OK.
991	8/5	-25	Fuze with proper firing pin spring and lead ring.	Stand	Could not be fired due to trouble with improperly assembled launchers. Test stopped
991	8/17	-25	"	"	Trigger Guard erected and thus conditioned. Fuze OK.
992-999	8/17	-25	"	"	Fuze OK. Propellant not fully burned.Low velocity.
1000-1002	8/25	-25	Test reworked launchers.	"	Trouble with test stand. Could not fire.
1003-1004	8/25	-25	"	Shoulder	Shoulder fired OK.
1005	8/25	-25	"	Shoulder	Shoulder fired.Barrier failed.Launcher exploded.

Round #	Date	Temp. °F	Test Purpose	Method of Firing	Result
1006	9/1	-25	Test launchers and aluminum barriers.	Stand	Stand reworked. Barrier and head moved forward. Did not separate completely.
1007-1012	9/1	-25	"	"	OK
1000-1002	9/1	-25	"	"	OK. Systems unchanged from 8/25.

SECRET





SECRET

THIS PRINT SUPERSEDES ALL PRINTS PRIOR TO:

HESSE—EASTERN, DIVISION
OF FLIGHTEX FABRICS, INC.
EVERETT 49, MASS.

POURING FUNNEL

PROJ. 509-3 | ASSY DWG
SCALE F... | REF DWG B 8691
MAT'L. SAME ...

BY	HAW	AUG 1 - 1960
CH'K'D	R	8/1/60
ENG'R	MC	8/1/60
APP'D	JC	8/1/60

B 8692 REV. 1

REVISIONS

1	RADIUS WAS 1/8	GPF 9-7-60

DO NOT SCALE DRAWING

ALL DIMENSIONS APPLY AFTER PLATING

125 FINISH ALL OVER EXCEPT WHERE NOTED

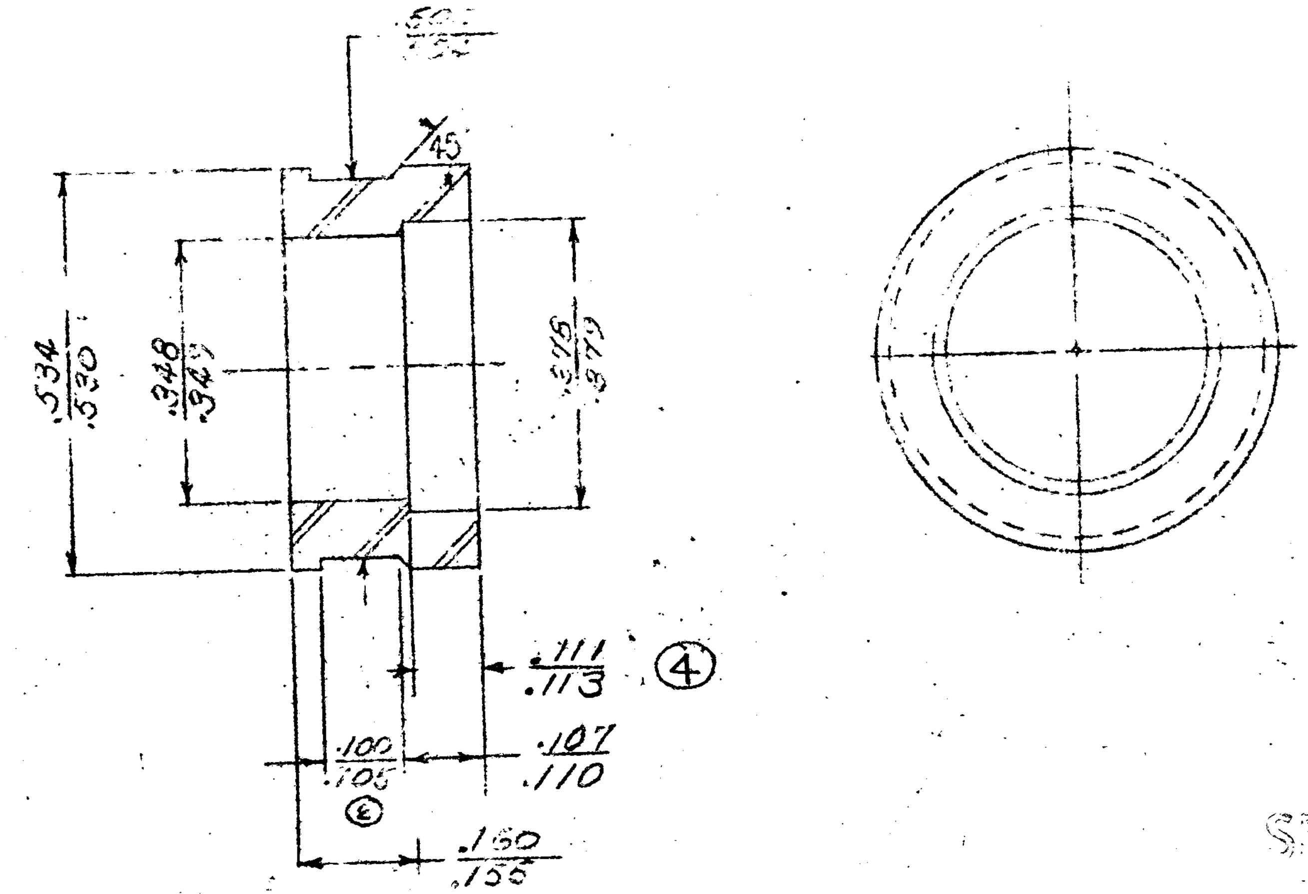
BREAK ALL SHARP CORNERS .005—.010

STANDARD TOLERANCES
DECIMAL ±.005
FRACTIONAL ±1/64
ANGULAR ±1°
ALL DIA. ON SAME ℄ TO BE CONCENTRIC WITHIN T.I.R.
UNLESS OTHERWISE NOTED

PRINTED BY SPAULDING-MOSS CO., BOSTON, MASS.

DWG NO. A –

SECRET



SECRET

4	WAS	.092 .098	8 22 60
3	ADDED		2/24/59
2	WAS .115 .120		
1			RW 3/2/59

REVISIONS

DO NOT SCALE DRAWING

ALL DIMENSIONS APPLY AFTER PLATING

125 FINISH ALL OVER EXCEPT WHERE NOTED

BREAK ALL SHARP CORNERS .005—.010

STANDARD TOLERANCES
DECIMAL +.005
FRACTIONAL ±1/64
ANGULAR ±1°
ALL DIA. ON SAME ℄ TO BE CONCENTRIC WITHIN T.I.R. UNLESS OTHERWISE NOTED

HESSE—EASTERN, DIVISION
OF FLIGHTEX FABRICS, INC.
CAMBRIDGE 38, MASS.

BY		3/29
CH'K'D	T.F	
ENG'R	T.F	12/31/57
APP'D		12/31/58

PROJ. 50G-1 | ASSY DWG B 8559
SCALE 4:1 | REF DWG D-8241-
MAT'L. STAINLESS STEEL (#303) ③

A 8153 REV. 4

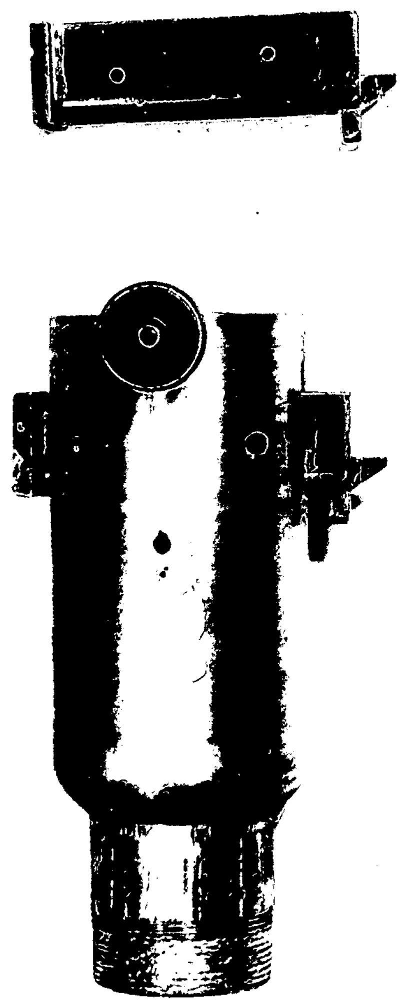


Photo No. 1

Top: Old Assembly Tool
Bottom: New Assembly Tool

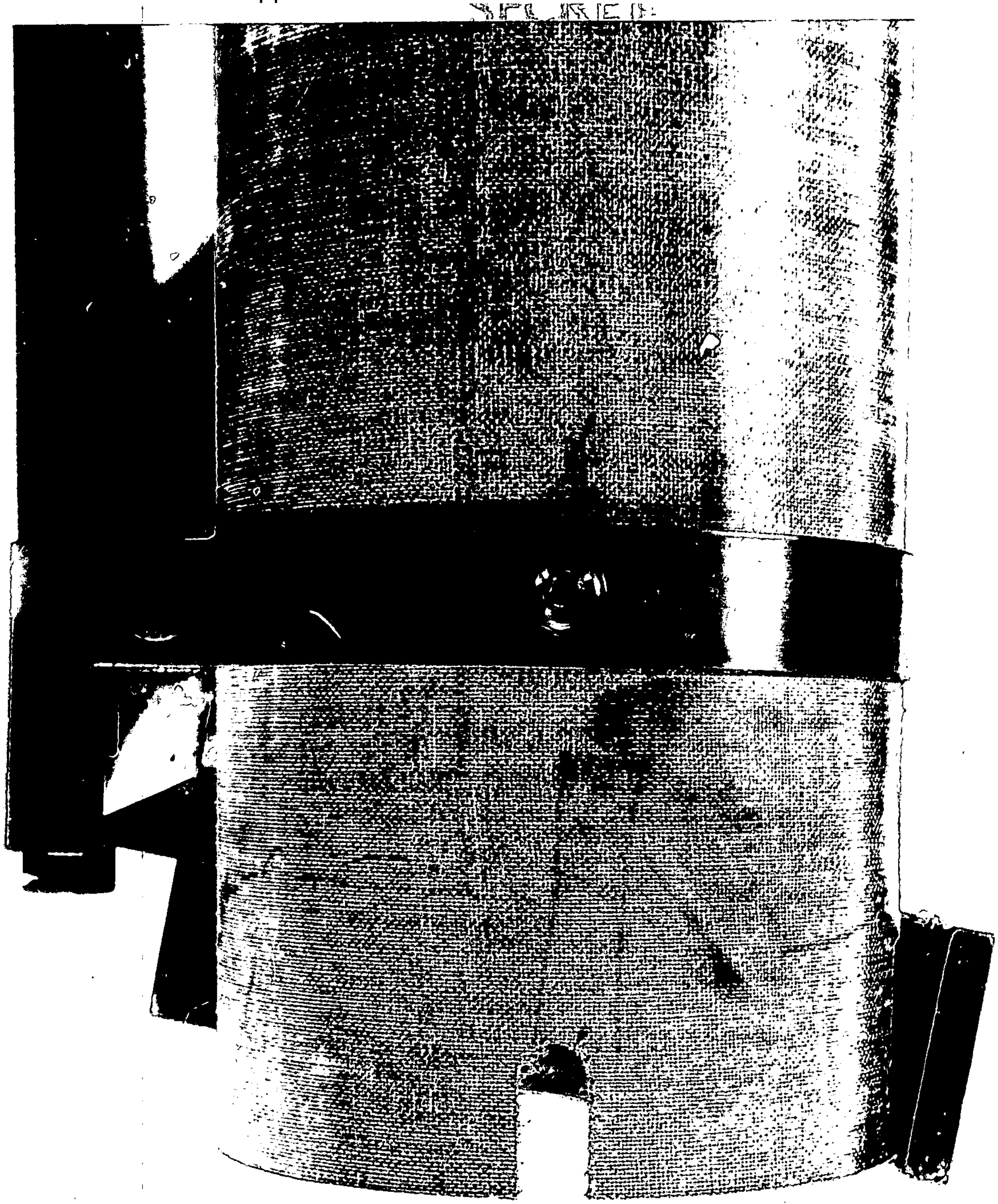


Photo No. 2

Exaggerated demonstration of possible misalignment using old tool.

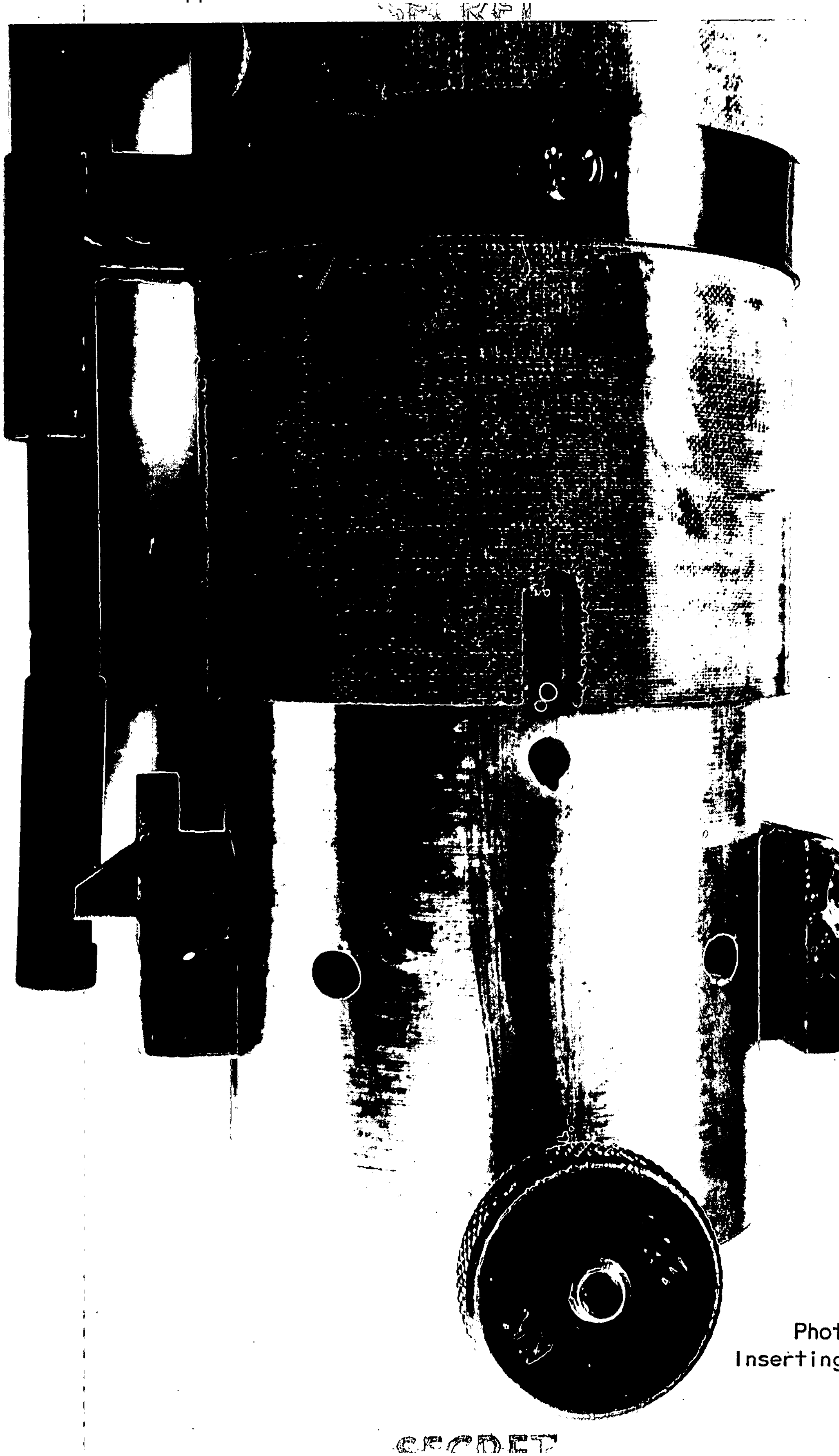


Photo No. 3
Inserting new tool.

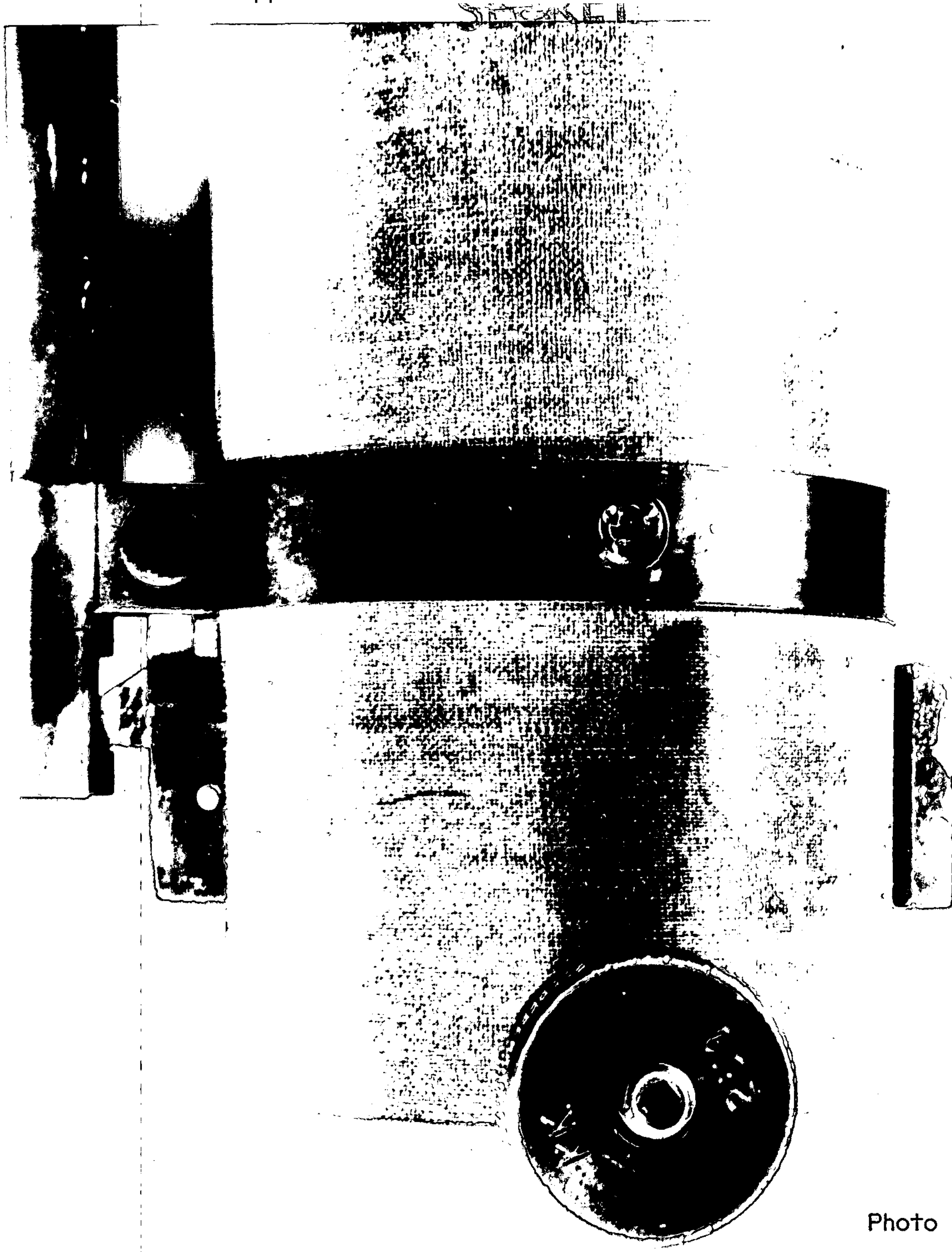


Photo No. 4

New tool clamped in position.

Declassified and Approved For Release 2011/11/08 : CIA-RDP78-03642A000800060006-1

SECRET

Declassified and Approved For Release 2011/11/08 : CIA-RDP78-03642A000800060006-1